ON THE CORRELATION OF MENTAL AND MOTOR ABILITY IN SCHOOL CHILDREN.

By WILLIAM CHANDLER BAGLEY, M. S., PH. D.,
Assistant in Psychology, Cornell University.

§ 1. INTRODUCTION.

In the fall of 1897 the writer began, under the direction of Professor Jastrow, of the University of Wisconsin, a study of the correlation of mental efficiency and motor ability in school children. The studies of Hancock[1] and Gilbert[2] in Worcester and New Haven, the investigations of Peckham[3] in Milwaukee, and the excellent work of Porter[4] in St. Louis, had paved the way for a study of this kind. The radical reforms in educational method, all directed upon a more complete recognition of the motor element in school work, seemed to demand such an investigation. The old proverb, "A sound mind in a sound body," had received an infusion of new life, and the principle which it adequately expressed found an extreme form of application in the elaborate organization of college athletics. At the same time, upon the intellectual side, the rise of a certain 'muscular' school of psychophysics, and still more, the prominence of a strenuous 'motor' cult in art and fiction, had done much toward giving an unusual importance to the motor aspects of education. All this was augmented from a strictly technical standpoint by the work of Porter who, after correlating the weight of St. Louis school children with their class-room records, found a marked tendency toward a direct relation between weight and mental 'precocity.' Weight, he then argued, easily stands for motor ability; hence the child increases in mental efficiency directly as he increases in motor ability.

The investigations upon which the following study is based

[1] Hancock, J. A.: A Preliminary Study of Motor Ability, *Pedagogical Seminary*, Vol. III, pp. 9-29. (October, 1894.)

[2] Gilbert, J. A.: Researches on the Mental and Physical Development of School Children, *Studies from the Yale Psy. Lab.*, Vol. II, pp. 40-100. (November, 1894.)

[3] Peckham, G. W.: The Growth of Children, *6th Annual Report Wisconsin State Board of Health*, Vol. VI, pp. 28-73. Madison, 1882.

[4] Porter, W. T.: The Physical Basis of Precocity and Dullness, *Transactions Academy of Science*, St. Louis. Vol. VI, pp. 161-181. (March, 1893.)

are far too limited in number to admit of wide generalization. The results, however, differ so radically from those of Porter that it is thought advisable to publish them, not with the belief that they will be accepted as conclusive in any respect, but with the hope that they may throw at least a glimmer of light upon some disputed points, as well as offer some suggestions which may be of value to future investigators.

§ 2. DATA.

The data of the study are drawn from four largely independent sources, two contributing the motor and two the mental data; of each of these, one source was experimental, the other non-experimental.

A. The Experimental Sources.

(*a*) *Motor.* The motor data were obtained experimentally by means of tests designed to determine motor ability in five respects: (1) strength, (2) rapidity of voluntary movement, (3) accuracy of voluntary movement, (4) control of voluntary movement or "steadiness" of motor co-ordination, (5) amount and character of involuntary movement. The apparatus used in the determination of these points will be described in detail later. The tests were designed to include the most important factors in motor ability, excellence in motor ability being measured by the strength, accuracy, rapidity, and steadiness of voluntary movement, accompanied by a minimum of involuntary movement.

(*b*) *Mental.* The experimental sources of the data on mental efficiency consisted of various types of reaction times as representing quantitatively the mental ability of the subject, mental excellence being represented by the alertness of the mind in reacting appropriately to given stimuli. These tests, which form an entirely independent study, were conducted by Miss Agnes Chapman, of the University of Wisconsin, as the basis for a baccalaureate thesis.

B. The Non-experimental Sources.

(*a*) *Motor.* The teachers in charge of the various pupils tested gave an estimate of the motor ability of the pupils as they had observed it in the process of the school work. The pupils were classed as "very clever," "clever," "medium," "awkward," and "very awkward." These terms were later translated into numerical symbols for convenience of manipulation.

(*b*) *Mental.* The mental data of a non-experimental type were derived in two ways. (1) From class-standings, as recorded in the school registers: the purely motor studies—writing and drawing—were eliminated, and the remaining standings aver-

aged upon a scale of 100 as numerical criteria of mental ability. (2) In order to eliminate the error that might arise from differences in standards used in marking by the several teachers, the estimates of the latter were again recorded,—this time the estimate of mental ability (independent of class records) being taken.

C. Auxiliary Data.

(*a*) *Personal.* The name, age, and grade of each pupil tested were recorded and spread upon the records of the tests together with the experimental data.

(*b*) *Anthropometric.* As material for possible correlations the following facts concerning each subject were recorded: weight in kg., height in mm., breadth of the head and length of the head,—taken at the usual points,—both in mm.

§ 3. APPARATUS AND METHOD.

Professor Jastrow's card-sorting apparatus was used in obtaining the reaction-times of the pupils. It will be found fully described, both as to structure and use, in the report of the American Psychological Association for 1897.

Following are brief descriptions of the various pieces of apparatus used in the motor tests, and of the methods employed:[1]

(*a*) The Test for Strength.

(1) *Apparatus.* For this test a dynamometer of a peculiar type was constructed. To the side of a fixed rectangular wooden frame, standing about 55 cm. from the floor, a spring balance was attached. An upward pull on the lower of a pair of grip-handles was transmitted by a lever movement to the spring of the balance. This balance was fitted with the usual recording scale; but in order to render the readings more exact the scale was discarded in practice, and its pointer used to move an arm 10 cm. long, so fixed upon a pivot that the free end described an arc of sufficient amplitude to admit of small graduations. The scale was then determined empirically, and graduated in kg.

(2) *Method.* The grip-handles were adjusted by thumb-screws to the desired distance (which, of course, varied with the size of the subject's hand); the height of the standard was not adjustable, but two small movable platforms rendered the apparatus available for subjects of all heights. Each subject was given three trials, being directed each time to grip the handles as tightly as possible with the right hand. The readings were recorded and averaged.

(*b*) The Test for Rapidity of Movement.

(1) *Apparatus.* "Trilling" a Morse key with the right forefinger was the test used to determine rapidity. The key was connected (*a*) with a dry battery of two cells, and (*b*) with an automatic recorder. The entire apparatus was securely fastened to a board (37.5 cm. square) which was placed on a table of the size used in the kindergarten.

(2) *Method.* The subject was seated before the table and directed to "trill" the key as rapidly as possible. As soon as the subject was able to manipulate the key readily, the operator switched in the current which started the recorder. The current was kept on for 10 seconds,

[1] The interested reader may be referred to the discussion of apparatus in the course of a study on a topic related to the present, by W. L. Bryan, *Amer. Jour. of Psych.*, V, pp. 125-204.

at the end of which time the operator opened the switch, the subject continuing to operate the key for a few seconds after the current had been shut off. Three successive records were taken in this way, and the results averaged.

(*c*) The Test for "Steadiness" of Motor Co-ordination.

(1) *Apparatus.* For this test a complicated scroll-plate was devised. A thin sheet of tin-foil was carefully smoothed out and waxed upon a piece of plate glass. Upon this foil a scroll diagram was first traced out and then cut, leaving a slit 1 mm. wide. This slit was continuous through all the complications of the scroll, but for convenience its course was divided into four sections, each representing a peculiar type of movement. The positive pole of the battery was connected with the edge of the foil, the negative pole with a tracing needle made by inserting a sewing needle into the end of a pencil holder and connecting it with the battery by means of a fine wire.

(2) *Method.* The scroll-plate was fastened upon the board used in the rapidity test, the subject was seated before it, given the pen, and directed to trace the pattern, being cautioned that he was to keep to the middle of the slit, every failure to keep away from the foil being recorded by a tap of an electric bell which was thrown into the circuit. The taps of the bell were recorded for each section of the scroll, as well as the time for each section, the total uumber of taps, and the total time.

(*d*) The Test for Accuracy and Constancy of Voluntary Movements.

(1) *Apparatus.* This test was made by a recording target (30x30 cm.) mounted upon a table (like the one used in the last two tests), the target being inclined backward to make an angle of 45° with the table-top. The target consisted of a wooden frame with a solid back, the frame being fastened to the back by means of hinges. Into this frame a sheet of paper was inserted having marked upon its center a black bull's eye 10 mm. in diameter. Behind this were a sheet of carbon paper and a sheet of record paper upon which the impressions were preserved.

(2) *Method.* The subject was placed two m. away, facing the target, and was prevented from approaching nearer by a movable upright. He was given ten marbles and directed to toss them, one at a time,—attempting to strike the bull's eye at each trial. After the ten marbles had been tossed the sheet was removed (after first receiving the impression of the bull's eye for reference in later measurements). This process was twice repeated, making three records in all.

These records were treated in two ways. In the first place the distance of each impression from the center was measured in mm. for the determination of the constant error of each sheet. The constant errors of the three sheets belonging to each subject were then averaged, and the result recorded as an index of motor accuracy. Then the average error was computed (per cent.) for each sheet, the three percentages of each subject being again averaged as an index of constancy of movement.

(*e*) The Test for Amplitude of Involuntary Movement.

(1) *Apparatus.* The apparatus used for determining the amplitude of involuntary movement was the automatograph designed by Professor Jastrow and known by his name. A full description will be found in the *American Journal of Psychology*, Vol. IV, pp. 398-407.

(2) *Method.* The automatograph was placed upon the table, the subject being directed to stand before it in such a position that the median plane of his body made an angle of 45° with the edge of the

automatograph opposite the recording pencil. The attention of the subject was then concentrated upon a metronome placed upon a table two m. in front of him. This metronome was set at 120 beats per minute, and the subject was directed to count the beats up to 120, raising his right hand and resting it, tips of the fingers down, upon the upper plate of the automatograph, when he began to count. At the same time the operator dropped the pencil upon the recording plate, leaving it there until the subject had completed the counting. Three records of this kind were taken. The total amplitude of movement was measured upon each record by means of a sliding compass, the average of the three record-amplitudes thus obtained being taken as an inverse index of the subject's excellence in the test. While every precaution was taken to make these measurements as exact as possible, they must still be interpreted rather as approximations than as exact determinations.

§ 4. Results.

The tests were begun December 13, 1897, at the Fifth Ward School, in Madison, and continued daily (during the school sessions) until the first of May, 1898. Each test occupied from twenty-five to forty-five minutes, the average being about thirty-five minutes. In all one hundred and sixty tests were made for motor ability, and one hundred and seventy-five for mental ability (reaction-times). Of these two series of tests one hundred and ten were upon the same pupils. For both tests additional data were collected from the school records and from the teachers' estimates as described above, but only for those who underwent the motor tests were anthropometric data tabulated.

Method of Treating the Data. The entire 'motor,' 'personal' and 'anthropometric' data were spread upon four large sheets of ruled paper. In this way the material was arranged in such a manner as to render it easy of manipulation. To the data thus arranged were added from time to time the class standings of the subjects as obtained from the teachers' registers and the teachers' estimates of mental and motor ability as translated into numerical terms, together with the "indices" (to be described later) of the mental alertness and motor ability of each subject as gained from the tests upon reaction-times, and from the motor tests.

The data as thus arranged were first examined with a view to determine general relations. The various columns were averaged, and from these averages curves of distribution were plotted.

Aside from this general treatment special correlations were made in the following manner.

The quantitative results of each important test were divided into five classes of thirty-two subjects each, the thirty-two having the highest records in each case being placed in the first class (designated Class AA), the thirty-two having the lowest being grouped in the last class (Class XX), while the remain-

ing ninety-six were similarly grouped into three intermediate classes (Classes A, M and X) in the order of their excellence. The data as arranged in this way for each test were spread upon separate sheets (one sheet for each class), and upon these same sheets were also placed the remaining data—mental, motor, personal, or anthropometric—which we wished to correlate with the given test, each line of figures across the page representing the results given by the same subject in the various tests. The vertical columns were then averaged, and a single correlation was completed.

An example of the process may make it clearer. We will suppose the results of the dynamometer test to have been arranged in five groups as just described. It is desired to correlate with this dynamometer test the standing obtained from the school registers. Along with the transfer of the dynamometer standings from the general sheet to the correlation sheet, the class standings are also transferred, the dynamometer record of each pupil being placed upon its appropriate sheet and the class standing of the subject represented being placed in an adjacent column. When the vertical columns are averaged, the general average dynamometer standing of the thirty-two subjects who were the best in the test is shown, and beside it is the average class standing of these thirty-two best dynamometer subjects. By this means, after averaging the remaining sheets in the same way, we arrive at what we may term a single or simple correlation, that is, a correlation of five groups, of a more or less uniformly varying scale of excellence in the given test, with the average class standings of these same groups. From this a curve may be plotted, the five averages of the correlating test being the five points of the curve as measured from one co-ordinate in terms of the five averages of the data with which the given test is correlated.

This method may be complicated by the following process. After making a simple correlation as above, arrange the data which have been correlated with the given test in five similar groups of thirty-two subjects each, arranged in the order of excellence as represented by these data.

To continue the above instance. If, after correlating the dynamometer test with the class standings singly as was described, it is wished to make a double correlation, the class standings may be arranged in five classes according to their degrees of excellence. Beside each subject's class standing, his dynamometer test may be recorded. These sheets, averaged as before, will give the average dynamometer results for each group of subjects arranged in order of class standings. If a curve is plotted from this latter correlation upon the same co-ordinates as the curve of the former correlation, and if care is taken to have the order of excellence in each case proceed from left to right upon the abscissa, and from below upward upon the ordinate, the following conditions may be observed:

(1) If the two curves have a general N. E. (northeasterly) direction (*i. e.*, from the meeting point of the co-ordinates to the upper right hand corner of the cross-section sheet), the correlation is direct; *i. e.*, the order of excellence in the one case bears a direct relation to the order of excellence in the other case.

(2) If the curves have a general S. E. (southeasterly) direction, the

correlation is antagonistic, *i. e.*, the order of excellence in the one case bears an inverse relation to the order of excellence in the other case.

(3) If the curves cross each other at right angles, the correlation is indifferent, the degree of indifference depending upon the degree to which the angle approaches 90°.

It may be well to add that these conclusions can be reached less satisfactorily from the single correlations, the general direction of the single curve giving some index as to the character of the correlation,—always providing that the order of excellence is as described above.

The Motor and Mental Indices. The terms "motor index" and "mental index" appear in several places in the Tables. The motor indices were derived as follows: The results of each test were arranged in the precise order of their excellence; the highest was then given an arbitrary value, 999, the others were given values in order down to 840 (which exhausted the 160 subjects). The process was completed for five tests, viz., the tests for rapidity, accuracy and steadiness of voluntary movement, the test for strength, and the test for amplitude of involuntary movement. Then these five motor standings of each subject were averaged, and an arbitrary symbol was obtained which represented the motor ability of each subject. This was called the motor index. Proceeding in the same general way we obtained a mental index from the mental tests and from the class-records. This mental index was taken to represent mental alertness, the handling time involved in the reaction experiments having been determined and eliminated.

The Teachers' Estimates. These were translated into numerical terms according to the following scheme. Motor ability: very clever, 5; clever, 4; medium, 3; awkward, 2; very awkward, 1. Mental ability: very bright, 5; bright, 4; medium, 3; dull, 2; very dull, 1.

§ 5. Interpretations and Conclusions.

(*a*) Comparisons of the various Motor Tests with the Class Standings. Double correlations.

In the following Tables the data mentioned first form the criteria for the division into the classes,—AA, A, M, X and XX. That is, in the first part of the following Table the class AA represents the thirty-two subjects who stood highest in the test for strength; the average of the class standings of these thirty-two is given directly below the figures which indicate the number of kg. which they registered on the dynamometer. In the second part of the Table the class AA represents the thirty-two who had the highest class standings. The average dynamometer 'pull' of *these* thirty-two is placed directly below their average class standing.

TABLE I.

Correlation of the Test for Strength and Class Standings.

CLASS.	AA.	A.	M.	X.	XX.
Dynamometer,	33.0	25.9	22.0	18.0	13.1
Standings,	75.4	80.0	83.97	85.71	82.92
Standings,	92.7	85.7	83.0	74.0	67.9
Dynamometer,	21.3	19.7	22.3	24.7	25.8

The above Table shows a decidedly inverse relation between mental ability, as indicated by class standings, and motor ability, as indicated by the dynamometer records.

TABLE II.

Correlation of the Test for Rapidity of Voluntary Movement and Class Standings.

CLASS.	AA.	A.	M.	X.	XX.
'Trilling,'	65.51	56.96	53.89	48.42	40.33
Standings,	80.31	82.18	85.90	79.39	79.30
Standings	92.7	87.5	83.0	74.0	67.9
'Trilling,'	52.3	50.7	53.4	51.6	53.6

This Table, in both its parts, is not conclusive. If the curve were plotted it would be 'indifferent.'

TABLE III.

Correlation of the Test for Steadiness of Voluntary Movement and Class Standings.

CLASS.	AA.	A.	M.	X.	XX.
'Tracing' Errors,	68.6	115.28	145.5	176.7	229.2
Standings,	78.1	81.44	77.1	82.45	90.88
Standings,	82.7	87.5	83.0	74.0	67.9
'Tracing' Errors,	164.8	145.0	133.1	135.1	136.3

A curve plotted from Table III would show a decidedly inverse relation between mental ability, as indicated by class standings, and motor ability, as indicated by the tracing test.

TABLE IV.

Correlation of the Test for Accuracy of Voluntary Movement and Class Standings.

CLASS.	AA.	A.	M.	X.	XX.
'Target' Test,	74.2	99.3	112.2	127.7	149.0
Class Standings,	78.2	78.5	84.3	81.8	83.9
Standings,	92.7	87.5	83.0	74.0	67.9
'Target' Test,	113.1	116.2	108.4	95.9	102.5

This Table, like the preceding, shows a predominantly inverse relation between motor ability and mental efficiency. The curve which might be plotted from it would, however, be less uniform than that of Table III.

TABLE V.

Correlation of the Test for Amplitude of Involuntary Movement and Class Standings.

CLASS.	AA.	A.	M.	X.	XX.
Automatograph,	46.3	69.9	86.9	98.9	137.9
Standings,	81.8	81.9	81.4	82.5	79.0
Standings,	92.7	87.5	83.0	74.0	67.9
Automatograph,	86.0	83.2	93.4	83.6	82.8

The curve from Table V would probably be classed as 'indifferent,' although it would show a very slight tendency toward the 'direct' relationship.

TABLE VI.

Correlation of the Test for Constancy of Voluntary Movement and Class Standings.

CLASS.	AA.	A.	M.	X.	XX.
Constancy Index,	29.12	34.3	39.7	42.8	51.7
Standings,	81.51	85.03	76.73	83.50	81.6
Standings,	92.7	87.5	83.0	74.0	67.9
Constancy Index,	40.5	40.3	39.5	41.8	38.9

The curve for Table VI would be rather less 'indifferent' than the curve for Table V, and the tendency would be toward an 'inverse' relation.

TABLE VII.

Correlation of the General Motor Index and Class Standings.

CLASS.	AA.	A.	M.	X.	XX.
Motor Index,	961.8	938.3	924.3	909.0	881.9
Standings,	77.8	80.0	83.6	83.8	84.7
Standings,	92.7	87.5	83.0	74.0	67.9
Motor Index,	917.2	907.1	922.8	931.0	931.05

In this Table the individual discrepancies of the preceding Tables are eliminated, and the curve would show a very marked inverse relation between motor ability, as represented by the various tests, and mental efficiency, as represented by the class standings.

(*b*) Comparisons of the Teachers' Estimates of Mental Ability with Class Standings and with the Motor Index.

TABLE VIII.

Correlation of Teachers' Estimates of Mental Ability and Class Standings.

CLASS.	AA.	A.	M.	X.	XX.
Estimates,	4.62	4.0	3.16	2.87	1.59
Standings,	90.5	86.28	77.0	82.43	71.9

This single correlation indicates that there is no appreciable discrepancy between the teachers' estimates of mental ability

and the values taken from the class records as representing mental ability.

TABLE IX.

Correlation of the Teachers' Estimates of Mental Ability and the Motor Index.

CLASS.	AA.	A.	M.	X.	XX.
Motor Index,	961.8	938.3	924.3	909.0	881.9
Estimates,	3.32	3.15	3.46	3.36	3.34
Estimates,	4.62	4.0	3.16	2.87	1.59
Motor Index,	908.0	924.4	901.6	913.3	926.8

While this Table lacks the uniformity of Table VII, the inverse relation is more than indicated.

(*c*) Comparison of Reaction Times with Class Standings and with the Motor Index.

TABLE X.

Correlation of Reaction Times and Class Standings.

CLASS.	AA.	A.	M.	X.	XX.
Reaction Times,	13.5	15.7	17.1	19.0	22.7
Standings,	78.8	82.2	80.6	82.3	77.3

This Table shows a discrepancy between the indices of mental ability as represented by class standings and by reaction times. The relation, however, is not inverse, but rather indifferent, the children whose reaction times are nearest the norm having the best class standings, while those who are particularly alert and those who are particularly slow in reaction are alike deficient in mental efficiency as represented by the class standings.

TABLE XI.

Correlation of Reaction Times and Motor Index.

CLASS.	AA.	A.	M.	X.	XX.
Reaction Times,	13.5	15.7	17.1	19.0	22.7
Motor Index,	928.6	930.9	935.2	928.6	935.2

Table XI, like Table X, is inconclusive, but shows a tendency toward an inverse relation between mental ability, as represented by reaction times, and motor ability, as represented by the motor index.

(*d*) The Elimination of the Age Factor.

In the above determinations the tendency toward an inverse relation between mental and motor ability is quite decided, even when mental ability is represented by two values as indifferent as regards each other as are the reaction times and the class standings. The factor of age, however, has not been considered, and it might very well be possible that this variable factor would compensate the differences which we have found. The

results which were obtained demonstrated conclusively that general motor ability increased with growth, but the relation between growth and mental ability was not so clearly shown. There is no alternative, therefore, but to eliminate in one way or another the factor of age. To do this the following course was pursued. The subjects were divided into five groups of thirty-two each upon the basis of age, the thirty-two oldest subjects being placed in Class AA, the thirty-two youngest in Class XX, and the remainder divided between Classes A, M and X in the order of age. Each of these classes was then treated exactly as the entire one hundred and sixty subjects were treated in the first instance, except that each was divided into four classes of eight subjects each, instead of into five classes of forty subjects each. The principle of division varied according to the information which was desired. Each Class (AA, A, M, X, and XX) was, for example, divided into groups of eight with regard to the motor index, or with regard to weight, or with regard to mental ability. In the last named case a slight departure was made from the former treatment. A 'mental index' was established for each subject in exactly the same way that the motor index had been established, except that only the class standings and the reaction times were used in the determination. By the aid of these mental and motor indices the comparison of mental ability and motor ability can be made with much more nicety than was possible under the former procedure.

TABLE XII.

Comparison of Mental and Motor Ability with Age Factor eliminated.

	Range of Age.	Av'age Age.	Class AA. (Best Average Motor Index.)		Class A. (2nd best Av. Motor Index.)		Class X. (3rd best Av. Motor Index.)		Class XX. (Lowest Av. Motor Index.)	
			Motor Index.	Mental Index.	Motor Index.	Mental Index.	Motor Index.	Mental Index.	Motor Index.	Mental Index.
AA	14–17	14.79	962.1	894.6	941.2	894.7	930.5	927.3	908.0	929.3
A	13–14	13.7	967.9	903.6	947.8	925.8	935.2	919.8	899.6	930.7
M	12–13	12.53	943.3	939.5	921.0	927.6	912.4	921.2	887.6	901.6
X	12–12	12.0	944.8	952.2	931.1	950.1	912.8	942.5	881.4	938.5
XX	8–11	10.6	926.5	944.5	902.2	948.3	889.9	958.0	874.5	934.2
	Averages.		928.9	906.8	928.6	909.3	916.1	933.7	890.2	926.8

1st half, average motor index, ... 928.7
" " " mental " 908.0
2d half, average motor index, ... 903.1
" " " mental " 930.2

The above Table shows very plainly the general tendency toward an inverse relation between mental and motor ability.

But it also shows that the law—if it be a law—is subject to numerous individual variations; and the discrepancies, especially in Class X, indicate that at certain periods of growth the relation between the two factors may be quite the reverse of the relation in general.

TABLE XIII.

Comparison of Weight, Class Standings and Motor Ability with the Age Factor eliminated.

(Range of age and average age same for each class as in Table XII.)

		Class AA { Highest Av. Weight.			Class A { 2d Highest Av. Weight.			Class X { 3d Highest Av. Weight.			Class XX { Lowest Av. Weight.		
		Weig't.	Motor Index.	Class Standings.	Weig't.	Motor Index.	Class Standings.	Weig't.	Motor Index.	Class Standings.	Weig't.	Motor Index.	Class Standings.
Oldest	AA	131.7	947.6	73.2	113.1	926.3	78.3	100.4	935.9	70.8	86.0	939.2	74.5
2d Oldest	A	105.1	930.4	74.8	92.6	958.2	77.7	86.9	929.7	74.2	77.2	929.3	78.5
3d Oldest	M	90.5	915.6	80.0	81.5	918.9	83.0	75.0	919.5	84.2	65.4	911.2	85.1
4th Oldest	X	101.2	922.6	85.2	88.2	912.2	85.6	78.2	920.3	90.5	69.8	909.4	83.8
Youngest	XX	89.2	905.2	85.2	73.2	896.7	88.7	66.8	894.2	84.7	57.7	897.6	86.2
Averages		103.7	924.2	79.6	89.7	922.4	82.6	81.4	919.9	80.8	71.2	917.3	81.6

1st half, average weight	96.7
" " motor index, ...	923.3
" " class standings, ...	81.1
2d half, average weight, ...	76.3
" " motor index, ...	918.6
" " class standings, ...	81.3

This Table does not indicate such a direct relation between weight and mental ability as Porter found in his investigations upon St. Louis school children. On the other hand,

the relation between weight and motor ability, with the age factor eliminated, while slightly direct, is mainly indifferent.

(*e*) Other Correlations.

The correlations which have been given above did not exhaust the data collected. Each set of determinations—personal, anthropometric, motor and mental—was correlated with every other set of determinations, with the hope of discovering some uniform relation between the various factors. To present the complete Tables exhibiting these correlations would, of course, be quite out of the question within the limits of the present paper. Some of the more important conclusions are, however, indicated in the following summary.

Summary.

1. Under the conditions of the investigation, and with the children that were tested, there is a general inverse relation between motor and mental ability; those who are the 'brighter' pupils and those who have the quicker reaction times being, as a rule, deficient in motor ability, while those who are best developed physically, who are the strongest, who have developed motor 'control' to the greatest extent, are generally deficient in mental ability. This rule, however, was found, with the children tested, to have numerous individual exceptions, and a varying validity at different periods of development.
2. There seems to be little direct relation between mental ability as represented by reaction times, and mental ability as represented by class standings, except that excellence in either of these directions is apt to be accompanied by a deficiency in motor ability.
3. There is a gradual increase of motor ability with age. The increase in mental ability is not so well marked.
4. In general, the boys slightly surpass the girls in motor ability, while the reverse obtains in mental ability.
5. Regarding cranial capacity as indicated by the head girths, we notice a significant trend toward an inverse relation between mental ability and head girth.